



Incidence and Risk Factors Associated with Acute Kidney Injury in the Pediatric Surgical Population

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INTRODUCTION

Pediatric acute kidney injury (AKI) is increasingly being recognized as a source of major morbidity and mortality. Studies of incidence and risk factors for AKI are limited to children undergoing cardiac surgery and those admitted to intensive care units^{1,2}. Our study aim was to evaluate the incidence and risk factors for AKI and in the non-cardiac pediatric surgical population. Our secondary aim was to examine the association between postoperative AKI and perioperative outcomes such as mortality, length of stay, and readmission.

METHODS

All patients 18 years and under who underwent non-cardiac surgery or procedures, between March 2013 and January 2018 at UCLA Medical Center and its affiliated surgery centers were identified. Cases were included if there was a baseline serum creatinine (SCr) level within 12 months prior to surgery and no documented or laboratory history of end-stage renal disease (ESRD). In patients with more than one surgery during a single admission, only the first case was included in the analysis. The Kidney Disease: Improving Global Outcomes (KDIGO) criteria were used to define AKI. Laboratory and descriptive data were gathered from the electronic medical record regarding potential risk factors including: age, ASA status, history of prematurity, congenital heart disease (CHD), and chronic kidney disease (CKD), as well as intraoperative characteristics, and postoperative outcomes. Reference values for blood pressure in children during anesthesia were derived from a large, multi-institutional reference³. Univariate analyses were performed examining risk factors for AKI, as well as association of AKI with perioperative outcomes, utilizing T-test and chi-square. Multivariate logistic regression was used to determine independently associated and odds ratios for each variable.

Table 1. Univariate Analysis of Risk Factors for AKI

	No AKI N=8636	Any AKI N=288	p-value
Age (years)	8.93 (6.02)	7.54 (6.20)	<0.001
Weight (kg)	35.1 (24.6)	27.7 (23.1)	<0.001
Sex (% male)	4896 (56.7%)	157 (54.5%)	0.463
CKD	134 (1.6%)	11 (3.8%)	0.003
CHD	1593 (18.4%)	62 (21.5%)	0.186
Prematurity	703 (8.1%)	26 (9.0%)	0.589
ASA E	475 (5.5%)	35 (12.2%)	<0.001
ASA status			
1	1179 (13.7%)	6 (2.1%)	<0.001
2	2762 (32%)	36 (12.5%)	
3	4283 (49.7%)	182 (63.2%)	
4	375 (4.3%)	58 (20.1%)	
5	22 (0.3%)	6 (2.1%)	
6	2 (0%)	0 (0%)	
General anesthetic	6094 (70.6%)	210 (72.9%)	0.389
Anesthesia duration (minutes)	169.71 (1538.9)	186.35 (164.1)	0.854
Transfusion RBC (ml)	11.22 (105.1)	56.18 (245.5)	<0.001
EBL	24.56 (125.6)	45.63 (212.4)	0.007
Average Duration <2SD MAP	2.32 (10.9)	5.43 (19.2)	<0.001
Average Duration 1-2SD MAP	14.00 (27.7)	18.20 (32.5)	0.012

Abbreviations: Estimated blood loss (EBL), red blood cell (RBC). Average duration <2SD MAP and 1-2SD MAP refers to duration of intraoperative mean arterial blood pressure less than 2 standard deviations (SD) below or between 1-2 standard deviations of the age- and sex-adjusted reference values, respectively. Data reported as mean (standard deviation) for continuous variables and as number (percent) for binary variables.

RESULTS

A total of 25,203 non-cardiac surgeries or procedures were performed during the 3.8-year period. Of these, 599 were excluded for ESRD, 1,987 were excluded due to their not being the first case within an admission, and 13,693 were excluded for lack of preoperative SCr. After excluding for these criteria, 8924 cases were analyzed. An overall 3.2% incidence of postoperative AKI was observed, with incidence of 1.8%, 1.2%, and 0.2% respectively of KDIGO stages 1, 2, and 3. Univariate analysis revealed several preoperative and intraoperative factors associated with AKI, including age, weight, CKD, ASA status, as well as intraoperative transfusion, blood loss, and hypotension (Table 1). Multivariate analysis demonstrated ASA status, weight, history of CHD, and intraoperative blood loss to be independently and significantly associated with postoperative AKI (Table 2). Univariate analysis revealed postoperative AKI to be significantly associated with inpatient mortality, length of stay, 30-day readmission, and other perioperative outcomes seen in Table 3.

Table 2. Multivariate Analysis of Risk Factors for AKI

	OR (95% CI)	p-value
Age (years)	1.04 (0.99-1.09)	0.096
Weight	0.85 (0.76-0.97)	0.012
Sex (% male)	0.87 (0.68-1.11)	0.253
CKD	1.90 (1.00-3.62)	0.05
CHD	0.69 (0.50-0.95)	0.022
Prematurity	0.73 (0.47-1.14)	0.165
ASA status	2.95 (2.45-3.56)	<0.001
ASA E	1.81 (1.17-2.80)	0.007
General anesthetic	0.97 (0.72-1.29)	0.824
Anesthesia duration	1.00 (0.99-1.01)	0.815
EBL	1.06 (0.99-1.12)	0.05
Average duration <2SD MAP	1.03 (0.96-1.11)	0.393
AUC (95% CI)	0.75 (0.72-0.77)	

Abbreviations: Area under the curve (AUC), confidence interval (CI), others as noted previously. Odds ratio for weight reflects interval of 10kg, anesthesia duration reflects interval of one hour, average duration <2SD MAP reflects an interval of 10 minutes, and for EBL reflects a volume of 100ml.

DISCUSSION

Based on data from a single institution, AKI is a morbidity that occurs not infrequently in the pediatric surgical population. ASA status, weight, CKD, CHD, and intraoperative blood loss were independently found to be significantly associated with postoperative AKI in the pediatric non-cardiac surgical population. Univariate analysis of AKI and perioperative outcomes seen here suggest AKI may have a major impact on long term morbidity and mortality. Further research is needed to better understand potential causative factors and associations with other outcomes.

Table 3. Univariate Analysis of AKI with Outcomes

	No AKI N=8636	Any AKI N=288	p-value
Mortality, In-hospital	57 (0.7%)	23 (8.0%)	<0.001
LOS	5.85 (18.0)	24.81 (37.3)	<0.001
LOS from surgery	4.54 (15.5)	20.20 (34.6)	<0.001
ICU LOS	65.42 (319.7)	281.66 (566.9)	<0.001
Ventilator time	0.30 (1.9)	1.25 (3.87)	<0.001
Floor-to-ICU Transfer	278 (3.2%)	46 (16.0%)	<0.001
Outpatient ICU Admission	12 (0.1%)	4 (1.4%)	<0.001
Readmission, 30-day	1976 (22.9%)	140 (48.6%)	<0.001

Abbreviations: Length of stay (LOS), intensive care unit (ICU). LOS and LOS from surgery reported in days, ICU LOS and ventilator time reported in hours. Data reported as mean (standard deviation) for continuous variables and as number (percent) for binary variables.

REFERENCES

- Kaddourah A et al. Epidemiology of Acute Kidney Injury in Critically Ill Children and Young Adults. N Engl J Med 2017;376:11-20.
- AlAbbas A et al. Epidemiology of cardiac surgery-associated acute kidney injury in neonates: a retrospective study. Pediatr Nephrol (2013) 28:1127-1134.
- De Graaf et al. Reference Values for Noninvasive Blood Pressure in Children during Anesthesia. Anesthesiology 2016; 125:904-13.